What is claimed is:

1. An illumination optical apparatus for illuminating an illumination objective plane with a light beam from a light source, comprising:

an optical integrator which is arranged in an optical path between the light source and the illumination objective plane and forms a multiple light source on the basis of the light beam from the light source; and

an aspect ratio-changing element which is arranged in an optical path between the light source and the optical integrator and which changes an aspect ratio of an incoming light beam in order to change an angle of incidence of the incoming light beam in a predetermined direction into the optical integrator.

2. The illumination optical apparatus according to claim 1, wherein:

the optical integrator includes a first optical integrator which is arranged in an optical path between the light source and the illumination objective plane and forms a first multiple light source on the basis of the light beam from the light source, and a second optical integrator which is arranged in an optical path between the first optical integrator and the illumination objective plane and forms a second multiple light source having light sources of a number larger than that of the first multiple light source

source on the basis of a light beam from the first multiple light source; and

the illumination optical apparatus further comprises a magnification-varying optical system which is arranged in an optical path between the first optical integrator and the second optical integrator and which similarly changes an entire size of the second multiple light source.

3. The illumination optical apparatus according to claim 2, wherein the aspect ratio-changing element is constructed to be rotatable about a center of an optical axis of the aspect ratio-changing element.

4. The illumination optical apparatus according to claim 2, wherein the aspect ratio-changing element includes a first aspect ratio-changing element which is arranged in the optical path between the light source and the first optical integrator and changes an angle of incidence of the incoming light beam into the first optical integrator in a first direction, and a second aspect ratio-changing element which is arranged in the optical path between the light source and the first optical integrator and changes an angle of incidence of the incoming light beam into the first optical integrator in a second direction perpendicular to the first direction.

5. The illumination optical apparatus according to

claim 2, wherein the aspect ratio-changing element includes a first prism which has a refractive surface having a concave cross section in the predetermined direction, a second prism which has a refractive surface having a convex cross section formed complementarily with the refractive surface having the concave cross section of the first prism, and a driving unit which is connected to at least one of the first prism and the second prism and moves at least one of the first prism and the second prism along an optical axis.

6. The illumination optical apparatus according to claim 5, wherein the concave cross section of the first prism has a V-shaped configuration.

7. An exposure apparatus for transforming a pattern on a mask onto a workpiece comprising:

the illumination optical apparatus according to claim 1, which illuminates the mask arranged at the illumination objective plane; and

a projection optical system which is arranged in an optical path between the mask and the workpiece and projects an image of the pattern onto the workpiece.

8. A method for producing a microdevice, comprising an exposing step of exposing the workpiece with the pattern on the mask with the exposure apparatus as defined in claim

7, and a developing step of developing the photosensitive substrate exposed in the exposing step.

9. The illumination optical apparatus according to claim 1, further comprising a guiding optical system which is arranged in an optical path between the optical integrator and the illumination objective plane and guides the light beam from the optical integrator to the illumination objective plane, and a light beam-converting element which is arranged in the optical path between the light source and the optical integrator and converts the light beam from the light source into a light beam having a predetermined cross-sectional configuration or a light beam having a predetermined light intensity distribution.

10. The illumination optical apparatus according to claim 9, wherein the aspect ratio-changing element is constructed to be rotatable about a center of an optical axis of the aspect ratio-changing element.

11. The illumination optical apparatus according to claim 9, wherein the aspect ratio-changing element includes a first aspect ratio-changing element which is arranged in the optical path between the light source and the optical integrator and changes an angle of incidence of the incoming light beam into the optical integrator in a first direction, and a second aspect ratio-changing element which

is arranged in the optical path between the light source and the optical integrator and changes an angle of incidence of the incoming light beam into the optical integrator in a second direction traverse to the first direction.

12. The illumination optical apparatus according to claim 9, wherein the aspect ratio-changing element includes a first prism which has a refractive surface having a concave cross section in the predetermined direction, a second prism which has a refractive surface having a convex cross section formed complementarily with the refractive surface having the concave cross section of the first prism, and a driving unit which is connected to at least one of the first prism and the second prism and moves at least one of the first prism and the second prism along an optical axis.

13. The illumination optical apparatus according to claim 12, wherein the concave cross section of the first prism has a V-shaped configuration.

14. An illumination optical apparatus comprising:

an illumination optical system which illuminates an illumination objective; and

a varying mechanism which is attached to the illumination optical system and varies at least one of a

size and a shape of an illumination light beam on a pupil of the illumination optical system, wherein:

the varying mechanism includes a first displacement unit which is arranged in an illumination optical path and displaces the illumination light beam symmetrically with respect to an optical axis of the illumination optical system in a first direction perpendicular to the optical axis.

15. The illumination optical apparatus according to claim 14, wherein the varying mechanism further includes a second displacement unit which is arranged in the illumination optical path and displaces the illumination light beam symmetrically with respect to the optical axis in a second direction which is perpendicular to the optical axis and which intersects the first direction, and a magnification-varying optical system which is arranged in the illumination optical path and varies the size of the illumination light beam.

16. The illumination optical apparatus according to claim 15, wherein the illumination optical system includes a light shape converter which is arranged in the illumination optical path and converts the shape of the illumination light beam into a desired light beam shape and which guides the illumination light beam converted to have the desired light beam shape to the varying mechanism.

17. The illumination optical apparatus according to claim 16, wherein the light shape converter includes a first diffractive optical member which is capable of inserting the illumination optical path and converts the shape of the illumination light beam into a first light beam shape, and a second diffractive optical member which is provided exchangeably with the first diffractive optical member and which converts the shape of the illumination light beam into a second light beam shape.

18. The illumination optical apparatus according to claim 15, wherein the illumination optical system includes an optical integrator which is arranged in an optical path between the varying mechanism and the illumination objective and which uniformly illuminates the illumination objective.

19. The illumination optical apparatus according to claim 18, wherein the optical integrator is a micro fly's eye or a rod type integrator.

20. An exposure apparatus for transforming a pattern on a mask onto a workpiece comprising:

the illumination optical apparatus according to claim 14, which illuminates the mask arranged at the illumination objective plane; and

a projection optical system which is arranged in an optical path between the mask and the workpiece and projects an image of the pattern onto the workpiece.

21. A method for producing a microdevice, comprising an exposing step of exposing the workpiece with the pattern on the mask with the exposure apparatus as defined in claim 20, and a developing step of developing the photosensitive substrate exposed in the exposing step.

22. The illumination optical apparatus according to claim 14, wherein the varying mechanism further includes an annular ratio-varying unit which is arranged in the illumination optical path and converts the illumination light beam into one having an annular configuration with a desired annular ratio.

23. The illumination optical apparatus according to claim 22, wherein the varying mechanism includes a magnification-varying optical system which is arranged in the illumination optical path and varies the size of the illumination light beam.

24. The illumination optical apparatus according to claim 22, wherein the varying mechanism further includes a second displacement unit which is arranged in the illumination optical path and displaces the illumination

light beam symmetrically with respect to the optical axis in a second direction which is perpendicular to the optical axis and which intersects the first direction.

25. The illumination optical apparatus according to claim 22, wherein the illumination optical system includes a light shape converter which is arranged in the illumination optical path and converts the shape of the illumination light beam into a desired light beam shape and which guides the illumination light beam converted to have the desired light beam shape to the varying mechanism.

26. The illumination optical apparatus according to claim 25, wherein the light shape converter includes a first diffractive optical member which is capable of inserting the illumination optical path and converts the shape of the illumination light beam into a first light beam shape, and a second diffractive optical member which is provided exchangeably with the first diffractive optical element and which converts the shape of the illumination light beam into a second light beam shape.

27. The illumination optical apparatus according to claim 22, wherein the illumination optical system includes an optical integrator which is arranged in an optical path between the varying mechanism and the illumination objective and which uniformly illuminates the illumination

objective.

28. The illumination optical apparatus according to claim 22, wherein the annular ratio-varying unit is a conical axicon.

29. An exposure method for exposing a workpiece with a pattern on a mask, comprising:

an illuminating step of illuminating the mask via an illumination optical system with an optical axis; and

a projecting step of projecting an image of the pattern on the mask onto the workpiece, wherein:

the illuminating step comprises displacing an illumination light beam symmetrically with respect to an optical axis of the illumination optical system in a first direction perpendicular to the optical axis on a pupil of the illumination optical system.

30. The exposure method according to claim 29, wherein the illuminating step further comprises converting the illumination light beam into one having an annular configuration on the pupil of the illumination optical system, and displacing the illumination light beam symmetrically with respect to the optical axis in a second direction which is perpendicular to the optical axis and which intersects the first direction.

31. The exposure method according to claim 30, wherein the illuminating step further comprises changing a size of the illumination light beam.

32. The exposure method according to claim 30, wherein the illuminating step further comprises converting a shape of the illumination light beam into a desired light beam shape before converting the illumination light beam into one having the annular configuration.

33. The exposure method according to claim 29, wherein the illuminating step further comprises displacing the illumination light beam symmetrically with respect to the optical axis in a second direction which is perpendicular to the optical axis and which intersects the first direction, and changing a size of the illumination light beam.

34. The exposure method according to claim 33, wherein the illuminating step further comprises converting a shape of the illumination light beam into a desired light beam shape before displacing the illumination light beam.

35. The exposure method according to claim 29, wherein the illuminating step further comprises converting the illumination light beam into one having an annular configuration on the pupil of the illumination optical

system, and converting an annular ratio of the converted annular illumination into a desired annular ratio.

36. The exposure method according to claim 35, wherein the illumination step further comprises changing a size of the illumination light beam.

37. The exposure method according to claim 35, wherein the illuminating step further comprises a second displacing step of displacing the illumination light beam symmetrically with respect to the optical axis in a second direction which is perpendicular to the optical axis and which intersects the first direction.

38. The exposure method according to claim 35, wherein the illuminating step further comprises converting a shape of the illumination light beam into a desired light beam shape before converting the illumination light beam into one having the annular configuration.

39. The exposure method according to claim 38, wherein the light shape-converting step includes converting the shape of the illumination light beam into a first light beam shape by using a first diffractive optical member, and converting the shape of the illumination light beam into a second light beam shape by using a second diffractive optical member which is provided exchangeably with the

first diffractive optical member.

40. The exposure method according to claim 35, wherein the illuminating step comprises uniformly illuminating the illumination objective by using an optical integrator.

41. The exposure method according to claim 29, wherein:

the illuminating step further comprises a changing step of changing an illumination condition for the mask;

the changing step comprises a selecting step of selecting at least one of a first setting step of setting a first illumination condition for the illumination optical system, and a second setting step of setting a second illumination condition for the illumination optical system;

the first setting step comprises a step of converting the illumination light beam into one having an annular configuration on the pupil of the illumination optical system, a step of displacing the illumination light beam symmetrically with respect to the optical axis in the first direction which is perpendicular to the optical axis of the illumination optical system, and a step of displacing the illumination light beam symmetrically with respect to the optical axis in a second direction which is perpendicular to the optical axis and which intersects the first direction; and

the second setting step comprises a step of displacing the illumination light beam symmetrically with respect to the optical axis in the first direction which is perpendicular to the optical axis of the illumination optical system, a step of displacing the illumination light beam symmetrically with respect to the optical axis in the second direction which is perpendicular to the optical axis and which intersects the first direction, and a step of changing a size of the illumination light beam.

42. The exposure method according to claim 29, wherein:

the illuminating step further comprises a changing step of changing an illumination condition for the mask;

the changing step comprises a selecting step of selecting at least one of a first setting step of setting a first illumination condition for the illumination optical system, and a second setting step of setting a second illumination condition for the illumination optical system;

the first setting step comprises a step of converting the illumination light beam into one having an annular configuration having a desired annular ratio on the pupil of the illumination optical system, and a step of changing a size of the illumination light beam; and

the second setting step comprises a step of displacing the illumination light beam symmetrically with respect to the optical axis of the illumination optical system in a

predetermined direction which is perpendicular to the optical axis, and a step of changing the size of the illumination light beam.

43. The exposure method according to claim 29, wherein:

the illuminating step further comprises a changing step of changing an illumination condition for the mask;

the changing step comprises a selecting step of selecting at least one of a first setting step of setting a first illumination condition for the illumination optical system, a second setting step of setting a second illumination condition for the illumination optical system, and a third setting step of setting a third illumination condition for the illumination optical system;

the first setting step comprises an annular ratio-varying step of converting the illumination light beam into one having an annular configuration having a desired annular ratio on the pupil of the illumination optical system, a step of displacing the illumination light beam symmetrically with respect to the optical axis of the illumination optical system in the first direction which is perpendicular to the optical axis, and a step of displacing the illumination light beam symmetrically with respect to the optical axis in a second direction which is perpendicular to the optical axis and which intersects the first direction;

the second setting step comprises a step of converting the illumination light beam into one having an annular configuration having a desired annular ratio, and a step of changing a size of the illumination light beam; and

the third setting step comprises a step of displacing the illumination light beam symmetrically with respect to the optical axis of the illumination optical system in the first direction which is perpendicular to the optical axis, a step of displacing the illumination light beam symmetrically with respect to the optical axis in the second direction which is perpendicular to the optical axis and which intersects the first direction, and a step of changing the size of the illumination light beam.

44. An exposure method for exposing a workpiece with a pattern on a mask, comprising:

an illuminating step of illuminating the mask via an illumination optical system;

a projecting step of projecting an image of the pattern on the mask onto the workpiece by using a projection optical system; and

a measuring step of measuring an optical characteristic of the projection optical system, wherein the illuminating step comprises:

an exposure condition-setting step of setting a σ value as an illumination condition to be within a range of $0.4 \leq \sigma \leq 0.95$ when the projecting step is executed; and

a measuring condition-setting step of setting the σ value as the illumination condition to be within a range of $0.01 \leq \sigma \leq 0.3$ when the measuring step is executed.

45. The exposure method according to claim 44, further comprising:

a scanning step of moving the mask and the workpiece in a scanning direction when the projecting step is executed, wherein:

the illuminating step comprises a step of forming a rectangular illumination area having a length Ls of a longitudinal direction and a length Ll of a transverse direction on the mask; and

a relationship of $0.05 < Ls/Ll < 0.7$ is satisfied.

46. An exposure apparatus for exposing a workpiece with a pattern on a mask, comprising:

an illumination optical system which is arranged in an optical path upstream of the mask and illuminates the mask; and

a projection optical system which is arranged in an optical path between the mask and workpiece and projects an image of the pattern on the mask onto the workpiece, wherein:

the illumination optical system includes an illumination condition-setting mechanism which is attached to the illumination optical system and sets a σ value as an

illumination condition to be within a range of $0.4 \leq \sigma \leq 0.95$ when the workpiece is exposed with the pattern on the mask and which sets the σ value as the illumination condition to be within a range of $0.01 \leq \sigma \leq 0.3$ when an optical characteristic of the projection optical system is measured.

47. The exposure apparatus according to claim 46, further comprising a scanning unit which moves the mask and the workpiece in a scanning direction when the workpiece is exposed with the pattern on the mask, wherein:

a relationship of $0.05 < Ls/L1 < 0.7$ is satisfied provided that Ls represents a length in a transverse direction of an illumination area formed on the mask by the illumination optical system, and L1 represents a length in a longitudinal direction of the illumination area formed on the mask by the illumination optical system.